

UNITED STATES PATENT APPLICATION

**Headset with Auxiliary Input Jack(s)
for Cell Phone and/or Other Devices**

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Cross-Reference to Related Applications

This application claims priority to co-pending and co-owned U.S. provisional application

5 60/397,888 (Attorney Dkt. 842.008PRV), filed July 22, 2002. The provisional application is incorporated herein by reference.

Technical Field

The present invention concerns headphones or headsets and related circuits and methods.

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Background

Headsets are used in variety of applications to facilitate one- or two-way audio communications between users and/or devices. For example, many aircraft pilots wear headsets to enable them to communicate via two-way radio with other aircraft and air-traffic controllers as well 15 as via a public-address system with passengers. Additionally, some headsets are worn to facilitate hands-free usage of mobile telephones, while others facilitate private listening to devices, such as computers, stereos, disk players, etc.

One problem that the present inventor recognized is that conventional headsets lack means for successfully integrating more than one audio source, despite their proximity to multiple sources 20 of audio signals. Accordingly, there is a need for headsets that facilitate use of more than one signal source.

Summary

To address this and/or other needs, the present inventors devised one or more devices, 25 circuits, and methods related to simultaneous connection of at least two audio input signals to a headset. For example, in one embodiment, an active-noise-reduction (ANR) headset includes at least one auxiliary port for connection to an output of at least one device, such as a personal communications, computing, and/or entertainment device. This exemplary headset also includes a

primary port for connection to a two-radio or public-address system and circuitry for automatically suppressing or muting the volume of an auxiliary input signal relative to that of a primary input signal.

Other exemplary features include a headset power supply, a microphone, a microphone 5 preamplifier, and a device-detection circuit. The device-detection circuit detects connection of the auxiliary port to a microphone input and couples the power supply to the microphone preamplifier, enabling it to provide audio signals to the microphone input.

Brief Description of Drawings

10 Figure 1 is a block diagram of an exemplary system 100 corresponding to one or more embodiments of the present invention.

Figure 2 is a flow chart of an exemplary method of operating one or more portions of system 100, which corresponds to one or more embodiments of the present invention.

15 Figure 3 is an electrical schematic of one or more exemplary circuits in system 100, each corresponding to one or more embodiments of the present invention.

Detailed Description of Exemplary Embodiments

The following detailed description, which references and incorporates the attached Figures, describes and illustrates one or more specific embodiments of the invention. These embodiments, 20 offered not to limit but only to exemplify and teach, are shown and described in sufficient detail to enable those skilled in the art to implement or practice the invention. Thus, where appropriate to avoid obscuring the invention, the description may omit certain information known to those of skill in the art.

Figure 1 show an exemplary system 100 incorporating teachings of the present invention. 25 Specifically, system 100 includes a primary audio communication device 110, a secondary audio communications device 120, and an automatic-noise-reduction (ANR) headset 130.

Primary communications device 110 includes, among other items not shown, a headphone output jack 112 and a microphone jack 114 coupled to internal circuitry not shown. In the exemplary embodiment, device 110 takes the form of a two-way aircraft radio, with headphone jack 112 being

a 0.250-inch female stereo plug connector and microphone jack 114 being a 0.206-inch, female stereo plug connector. In some embodiments, device 110 includes a public-address or intercom capability.

Secondary communications device (or system) 120 includes, among other items (not shown), 5 an audio output jack 122 and an external microphone jack 124. In the exemplary embodiment, communications device 120 takes the form of a cellular telephone, with output jack 122 and microphone jack 124 coupled to interface circuitry (not shown) which supports use of a conventional hands-free mobile-phone headset, which includes a microphone and an ear-piece (or headphones). (Hands-free headsets typically include an unbuffered electret microphone that is powered by 10 interface circuitry (not shown) in the cell phone or other type secondary device. In the exemplary embodiment, this interface circuitry is not suitable for boom microphones in aviation headsets.)

In some other embodiments, device 120 takes the form of a two-way radio, laptop computer, or other audio source or audio output device, such as a music or video player or other personal listening device. In still other embodiments, device 120 includes or is coupled to an input/output 15 port of a larger multiport distribution network that distributes audio signals, for example, throughout an airliner.

ANR headset 130 includes, among other things, an earpiece 132, a boom microphone 134, and a controller 136. Earpiece 132, which each take the exemplary form of circumaural earcup in this embodiment, fits over respective ear of a user (not shown). However, in other embodiments, 20 the earpiece takes the form of supraural, in-the-ear, or behind-the-ear devices. Specifically, earpiece 132 includes ANR control circuitry 1321, an ANR microphone 1322, an ANR speaker 1323, a non-ANR speaker 1324.

Boom microphone 134 includes a boom 1341 which extends from one of earpieces 132, and a microphone 1342 positioned at an end of the boom. Other embodiments use other forms of 25 microphones. Earpiece 132 and boom microphone 134 are both coupled to controller 136.

Controller 136 includes secondary-device detector 1361, a boom microphone preamplifier 1362, a comm-priority module 1363, a battery box 1364, and user controls 1365. In the exemplary embodiment, the controller is provided as a box or module separate from the earpieces; however, in some embodiments, all or one or portions of the controller are incorporated into one or more of

the earpieces. For example, some embodiments place one or more of the controller input jacks directly on one of the earpieces.

Secondary-device detector 1361 is coupled to microphone jack 124 of secondary communications device 120, microphone preamplifier 1362, and battery box 1364. Microphone 5 preamplifier 1362, in the exemplary embodiment, is designed to operate using a 5-10 VDC voltage source and a 600-2000 ohm resistor. Comm-priority module 1363 is coupled to headphone jack 122 of primary communications device 110 and to audio output jack 122 of the secondary communication. Manual controls 1365 include on-off switch, left-right volume controls, stereo-mono switch, mode-programming switches, and bass and treble controls (all not shown separately.)

10 In general operation, secondary device detector 1361, which includes an audio input jack coupled to microphone jack 124 of secondary communications device 120, senses or detects connection or activation of device 120 to headset 130 and in response couples power derived from battery box 1364 to boom microphone preamplifier 1362. Comm-priority module 1363, which is coupled to the headphone jack of the primary communications device and to an audio output jack 15 of the secondary communication, provides an automatic muting or attenuation function that reduces the volume or amplitude of an audio or electrical signal derived from the secondary communication device relative to the volume or amplitude of an audio or electrical signal derived from the primary communications device. Detector 1361 also senses decoupling or deactivation of device 120 and in turn decouples battery box 1264 from boom microphone preamplifier 1362.

20 More particularly, Figure 2 shows a flow chart 200 of one or more exemplary methods of operating system 100, particularly in relation to control module 136. Flow chart 200 includes process blocks 210-280, which are arranged and described serially for clarity. However, two or more of the blocks, in whole or in part, can be executed in parallel. Additionally, some embodiments may alter the process sequence by omitting or adding one or more blocks or provide different functional 25 partitions to achieve analogous results. Moreover, still other embodiments implement one or more of the blocks using a processor or programmable logic device and an electronic, magnetic, or optical storage medium bearing machine-executable instructions for execution or facilitating execution of one or more portions of the exemplary method. Thus, the exemplary process flow applies to software, hardware, firmware, and other implementations beyond those exemplified here.

At block 210, exemplary execution begins with determining whether a secondary device, such as secondary communications device 120, is coupled to headset 130, or more precisely control module 136. In the exemplary embodiment, this entails using detector 1361 to detect or sense a preamplifier bias signal from secondary communications device 120. In some embodiments, the 5 preamplifier bias signal is a 2.5VDC signal, which is generally incompatible with the bias signal used in most aviation-grade ANR headsets. Other embodiments may use the state of a switch to determine connection of a second device. If the determination is that a secondary device is coupled to the headset, execution advances to block 220.

In block 220, detector 1361 couples power derived from battery box 1364 to microphone 10 preamplifier 1362, thereby enabling the headset to self-power its boom microphone rather than relying on power from the primary communications device. This self-powering feature allows one to use the headset with the secondary communications device independent of any connection to the primary communications device. One benefit of this feature is that it allows the secondary device to be used in a noisy environment with no other electronics or power beyond the headset itself. 15 Execution of the exemplary method continues at block 230.

Block 230 entails headset 130 receiving audio signals from one or the other or both of the primary and the secondary communications devices 110 and 120. In the exemplary embodiment, these audio signals are received at comm-priority module 1363 via headphone jack 112 and/or audio output 122. Execution then proceeds to block 240.

20 Block 240 entails determining whether to alter the relative amplitude of the primary and secondary audio signals. In the exemplary embodiment, this entails comparing the primary audio signal (more precisely the voltage at headphone jack 112) to a threshold voltage. If the comparison indicates that the primary audio signal is greater than the threshold voltage, execution advances to block 250; otherwise execution branches to block 260.

25 Block 250 entails altering the relative amplitude of the primary and secondary audio signals. In the exemplary embodiment, this alteration entails reducing the amplitude (or volume) of the secondary audio signal relative to that of the primary audio signal. Some embodiments may increase the amplitude or volume of the primary audio signal to be greater than that of secondary audio signal.

Some embodiments may additionally output a notification signal, such as high-pitched tone or beep, to indicate presence of an primary audio signal in excess of the threshold.

Block 260 entails mixing the primary and secondary audio signals. In the exemplary embodiment, this mixing entails mixing the primary audio signal, or more precisely any voltage 5 present on headphone jack 112 with the reduced or unreduced secondary audio signal.

Block 270 entails outputting the mixed primary and secondary audio signals to one or both of earpieces 132. In the exemplary embodiment, the mixed signals are output to speaker 1324 and to ANR circuitry 1321. Some embodiments, however, may omit or bypass the ANR circuitry. Execution then returns back to block 210.

10 Block 210 determines whether there is still a secondary device coupled to the headset. If the determination is that a device is still coupled to the headset, execution continues to block 220, as previously described. However, if the determination is that there is no secondary device (or that the secondary device has been deactivated, for example, as evidenced by failure to receive a microphone bias voltage from the device), then execution advances to block 280, which entails 15 decoupling of the headset battery from the boom microphone preamplifier to conserve battery power.

Figure 3 shows circuitry 300, which includes a detector circuit 310 that represents an exemplary implementation of secondary-device detector 1361 and a comm-priority circuit 320 that represents an exemplary implementation of comm-priority module 1363. In the figure, incoming signals from the secondary device are received at secondary inputs Aux_R and Aux_L, 20 and incoming signals from the primary device are received at COM_AUD TIP and COM_AUD GND. Battery terminals (shown in the lower lefthand corner) are labeled Bat+ and Bat-.

Detector circuit 310 detects the presence of an external bias signal at an audio input jack (denoted cell_mic in the figure) via a transistor Q6, which turns on the current source comprising a transistor Q10. Activation of the current source provides a bias current for the boom 25 microphone preamplifier. The current source has a compliance of over 10VDC for undistorted communications at high-sound pressures. Notably, this implementation does not interfere with normal operation of the boom microphone preamplifier, if it is connected to a radio or intercom bias circuit because it is a current source realizing a high Thevinin equivalent impedance.

Although not preferred, some embodiments may use a source with a low Thevenin equivalent impedance.

Comm-priority circuit 320 treats the Com_L input as the primary input to the headset and compares this signal to a threshold voltage via comparitor circuitry that includes operational amplifier U1B. If the signal at the Com_L input exceeds the trigger threshold (set by resistors R1 and R2, voltage V+, and processor output pin 11), then the output of operational amplifier U1B output goes high, saturating transistor Q8 and causing this transistor to rapidly discharge capacitor C1. In response to this discharge, operational amplifier U1C produces a low voltage at its output, which is coupled to a pulse-width-modulation (PWM) circuit comprising oscillator 10 U4 and PWM comparitor U3.

In turn, the PWM circuit reduces the duty cycle of its output signal. This output signals controls analog switch U11 (4053), which is part of a chopping circuit, causing it to attenuate the auxiliary inputs Aux_L and Aux_R. U1a and U1d denote summing amplifiers that sum or mix the primary and secondary inputs, and also provide a reconstruction filter for the chopped signal. 15 The output of summing amplifiers U1a and U1d are then passed up to the earpieces for transduction into acoustic signals.

When the primary audio input stops exceeding the trigger threshold, capacitor C1 slowly starts to charge up via resistor R3, thus increasing the duty cycle of the signal output from the PWM circuit and the gain level of the secondary audio input. The exemplary embodiment 20 increases this gain linearly until it reaches its original level. (Non-linear restoration of the secondary signal is also feasible.) Microprocessor U5 is programmable via control inputs Control1 and Control2 to disable communications priority by setting processor output pin 11 to a high logic state and thereby moving the trigger threshold for initiating attenuation of the secondary input to a high value.

25 Other implementations could assign priority to the secondary inputs or allow the user to select which inputs have priority. The comm-priority functionality is selectable and controlled through microprocessor U5 using a combination of pushes of a button on a separate control module, such as module 136. Other embodiments place this control with controls on one or more of the earcups, the bridge between the earcups, or other convenient location.

Conclusion

The embodiments described above are intended only to illustrate and teach one or more ways of practicing or implementing the present invention, not to restrict its breadth or scope. The actual 5 scope of the invention, which encompasses all ways of practicing or implementing the concepts of the invention, is defined by the following claims and their equivalents.